

**Certification Preparation
Math for the Associate Safety
Professional/Certified Safety
Professional/Occupational Health and
Safety Technician Examination
(WF06)**

**Answers Reference
Guide to Group Exercises,
Practice Tests, and Final Exam**

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**Commander Joselito Ignacio, CIH, CSP, REHS, MPH
U.S. Public Health Service Officer
Detailed to U.S. Coast Guard**

Group Exercises

Group Exercise

Using calculator, solve for x in the following problems

$$8. \quad \sqrt{(24+x)} = 36 \quad (\sqrt{24+x})^2 = (36)^2$$

$$24+x = 1296$$
$$\boxed{x = 1272}$$

$$9. \quad \left[\frac{23}{x}\right]^5 + 25 = 14$$

$$-1 \left[\left(\frac{23}{x}\right)^5 \right]^{1/5} = [14 - 25]^{-1}$$
$$\left[\left(-\frac{23}{x}\right)^5 \right]^{1/5} = (-11)^{1/5}$$
$$\frac{-23}{x} = 1.62$$
$$\boxed{x = -14.2}$$

Group Exercise on Simple Conversions

Using the given conversion factors, solve the following

- Given that 2 pints equals 1 quart, how many pints do I need to fill a 6 quart container?

$$6 \text{ qts} \times \frac{2 \text{ pts}}{1 \text{ qt}} = \underline{\underline{12 \text{ pts}}}$$

- Given that 1 foot equals 12 inches, how many feet of plywood is needed if the design requires 245 inches of it?

$$245 \text{ in} \times \frac{1 \text{ ft}}{12 \text{ in}} = \underline{\underline{20.4 \text{ ft}}}$$

- Given that 2 pounds equals 454 grams, how many grams of chemical A do I need if the procedure requires 10 pounds of it.

$$10 \text{ lbs} \times \frac{454 \text{ g}}{2 \text{ lbs}} = \underline{\underline{2270 \text{ gr}}}$$

Group Exercise on Simple Conversions

Using the given conversion factors, solve the following

4. Given that 3 feet equals 1 yard, how many feet is there in a 500 yard firing range?

$$500 \text{ yd} \times \frac{3 \text{ ft}}{1 \text{ yd}} = \underline{\underline{1500 \text{ ft}}}$$

5. Given that 100 centimeters equals 1 meter, how much snow is reported in centimeters if there is 24 meters worth measured?

$$24 \text{ m} \times \frac{100 \text{ cm}}{1 \text{ m}} = \underline{\underline{2400 \text{ cm}}}$$

6. Given that 4 quarters equals 1 dollar, how many quarters do I need in a vending machine for a \$2.50 sandwich?

$$\underline{\underline{10 \text{ quarters}}}$$

Group Exercise - Conversions

Use your reference handout for conversion factors

1. A sling is load tested at 2300 pounds. A steel beam is labeled to weigh 1400 kilograms.
Can the sling lift this item?
 $\frac{1\text{kg}}{2.2\text{lbs}} \times \frac{145.5\text{ kg}}{2.2\text{ lbs}} = \underline{1045.5\text{ kg}}$ - Yes

2. In a 500 gallon water trailer, how much does the water weigh when filled to 500 gallons?
Hint: Weight Density of water is 62.4 lbs per cubic foot; $\frac{1\text{gallon}}{0.035\text{ ft}^3} \times \frac{62.4\text{ lbs}}{1\text{ ft}^3} = \underline{4121\text{ lbs}}$

3. An attic flooring space is load rated at 62 lbs per square foot. If the total square footage is 42 square feet, what is the load rating for the entire attic space?

$$42\text{ ft}^2 \times \frac{62\text{ lbs}}{\text{ft}^2} = \underline{2604\text{ lbs}}$$

Group Exercise - Conversions

Use your reference handout for conversion factors

4. A bridge is rated to 500 lbs per square feet. A heavy machinery taking 1 square feet of space is labeled to weigh 550 kilograms. Can this be placed on the bridge?

$$550 \text{ kg} \times \frac{2.2 \text{ lbs}}{1 \text{ kg}} = 1210 \text{ lbs} - \underline{\text{NO}}$$

5. A human runner was clocked to have run a 150 meter relay in 45.6 seconds. How many miles per hour is that equivalent to? Hint: 5280 feet = 1 mile; 60 seconds = 1 minute

$$\frac{150 \text{ m}}{45.6 \text{ sec}} \times \frac{1 \text{ min}}{60 \text{ sec}} \times \frac{100 \text{ cm}}{1 \text{ m}} \times \frac{3 \text{ ft}}{2.54 \text{ cm}} \times \frac{1 \text{ ft}}{12 \text{ in}} \times \frac{1 \text{ mile}}{5280 \text{ ft}} = \underline{7.4 \text{ mph}}$$

6. A forklift is load tested to 450 lbs. In Europe, how many kilograms is that?

$$450 \text{ lbs} \times \frac{1 \text{ kg}}{2.2 \text{ lbs}} = \underline{205 \text{ kg}}$$

Group Exercises

1. Your company is designing a spill containment measuring 50 feet long, 40 feet wide, and 3 feet high. In the dike, there is a cylindrical fuel tank measuring 25 feet high and 20 feet in diameter. The local law requires containment to hold 110% of the total storage capacity.

Does this containment design meet this local requirement?

$$V_t = \frac{\pi d^2 h}{4} = \frac{\pi (20')^2 (25')}{4} = 7854 \text{ ft}^3 \times 1.10 = 8,639 \text{ ft}^3 \text{ minimum storeable capacity for dike}$$

$$V_{dike} = 50' \times 40' \times 3' = 6000 \text{ ft}^3$$

V_{dike} < V_{tank} => NOT IN COMPLIANCE

2. A forklift manufacturer recommends a maximum incline of 3.5% when transporting up to its load test limit of 450 lbs. There is a ramp that is 45 feet in driveway length, and a 5 feet rise. Will this ramp exceed the forklift manufacturer's recommendation if the forklift will routinely carry loads up to 450 lbs?

$$\text{Incline \%} = \frac{\text{Rise}}{\text{Driveway Length}} \times 100 = \frac{5}{45} \times 100 = 11.1\% \text{ Yes, will exceed MFR recommendation.}$$

Group Exercises

3. Using problem#2, what is the angle of the incline on this ramp?

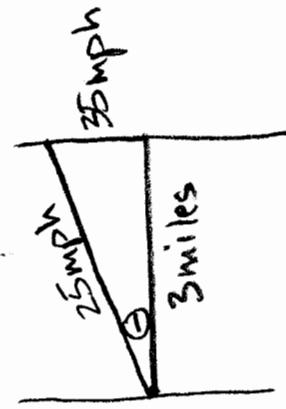
$$\begin{array}{l} \text{45'} \\ \text{5'} \\ \hline \end{array}$$
$$\sin \theta = \frac{5}{\sqrt{45}}$$
$$\theta = \arcsin \frac{5}{\sqrt{45}} \approx 64.4^\circ$$

4. Find the length of a ramp if the height is 6.5 feet and the ramp's angle is 5 degrees.

$$\begin{array}{l} 6.5 \\ \hline \end{array}$$
$$\sin(5^\circ) = \frac{6.5}{x}$$
$$x = \frac{6.5}{\sin(5^\circ)} \approx 74.6'$$

5. A boat carrying hazardous material must traverse river that is 3 miles long to a point directly across from its origin.. The river's current is 35 mph. If the boat will cruise at approximately 40 mph, what is the appropriate heading relative to the other side should the boat aim for in order to arrive at its destination directly.

$$\sin \theta = \frac{35 \text{ mph}}{40 \text{ mph}} = \frac{7}{8}$$



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Group Exercise

6. A room has the following dimensions: 25 feet long, 14 feet high, 20 feet wide. If the recommended amount of air per person inside a room is 55 m^3 per person, what is the maximum number of people allowed in this room.

$$V = 25' \times 14' \times 20' = 7000 \text{ ft}^3$$

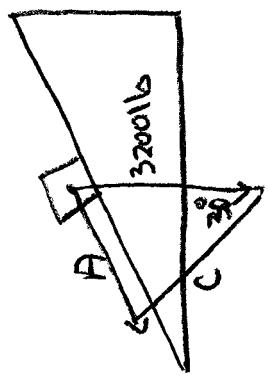
$$7000 \text{ ft}^3 \times \frac{1 \text{ m}^3}{35.3 \text{ ft}^3} = 198.3 \text{ m}^3 \times \frac{1 \text{ person}}{55 \text{ m}^3} = 3.6 \approx \underline{\underline{3.0}}$$

7. In a tank farm, a fuel storage tank 145 feet in diameter and 48 feet high has no diking. If the local diking requirement is 115% of capacity, what should the dike's capacity be?

$$V = \frac{\pi d^2 h}{4} = \frac{\pi (145')^2 (48')}{4} = 792624 \text{ ft}^3 \times 1.15 = 911,517 \text{ ft}^3$$

Group Exercises

1. A ramp with a 30 degree incline angle must be used to transport a 3200 lb aircraft component. If the ramp has a coefficient of friction of 0.15, how much additional force must be added to keep the component from slipping?



$$(1) \sin(30^\circ) = \frac{A}{3200 \text{ lbs}} \Rightarrow A = 1600 \text{ lbs}$$

$$(2) \cos(30^\circ) = \frac{C}{3200 \text{ lbs}} \Rightarrow C = 2771 \text{ lbs}$$

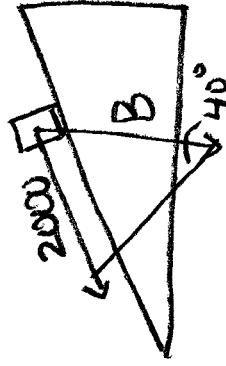
$$F = \mu N = (.15)(2771) = 415.71 \text{ lbs}$$

$$(3) 1600 \text{ lbs} - 415.7 \text{ lbs} = \underline{\underline{1184 \text{ lbs}}}$$

2. Assuming a frictionless surface, a 2,000 lb forklift is keeping an object from slipping down a ramp, inclined at 40 degrees. How much must this object weigh?

$$\sin(40^\circ) = \frac{2000}{B}$$

$$3111.4 = \underline{\underline{B \text{ lbs}}}$$



Group Exercises

3. A vehicle is traveling 45 meters per second. If the vehicle weighs about 2500 lbs, how much kinetic energy must it have?

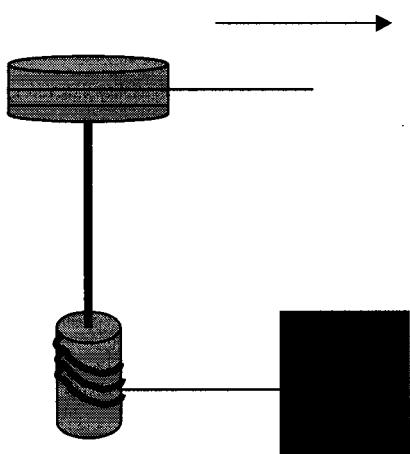
$$KE = \frac{M V^2}{2} = \frac{(115,924 \text{ kg}) (45 \text{ m/s})^2}{2} = 117,367 \text{ Joules}$$

$$2500 \text{ lbs} \times \frac{1 \text{ kg}}{2.2 \text{ lbs}} = 1136 \text{ kg} \rightarrow W = mg \Rightarrow m = \frac{1136 \text{ kg}}{9.8 \text{ m/s}^2} = 115.92 \text{ kg}$$

4. A tower crane operator is asked to lift a load at about 230 feet out from its mast. If it is counterweighed at 350,000 lbs at 25 feet from its mast, what is the maximum load a that reach can the crane safely lift?

$$\begin{aligned} F_1 D_1 &= F_2 D_2 \\ (350,000)(25) &= F_2 (230') \\ 38,000 \text{ } \cancel{\text{lbs}} &= F_2 \end{aligned}$$

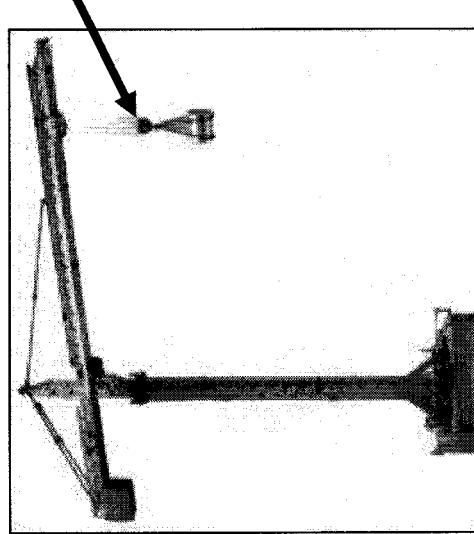
Group Exercise



1. The box's weight is 230 lbs. If the diameter of the small pulley is 1 foot and the diameter of the large pulley is 4 feet, how much force is required to pull downward to lift the object?

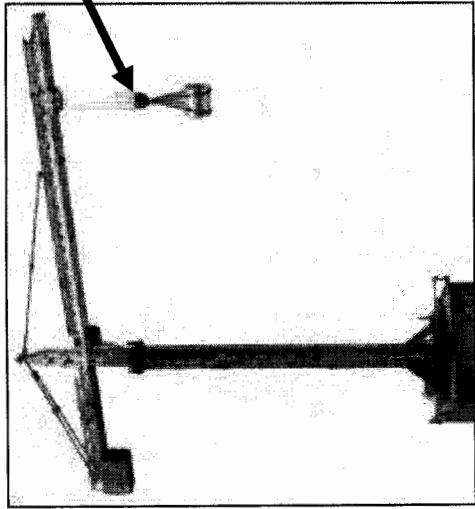
$$\frac{1}{4} (230 \text{ lbs}) = \underline{57.5 \text{ lbs}}$$

2. This tower crane uses a 7 line pulley system. If the load weight is 230,000 lbs, what is the actual upward force required to lift the object?



$$\frac{1}{7} (230,000 \text{ lbs}) = \underline{32,857 \text{ lbs}}$$

Group Exercises



3. Using the same 7 line pulley, if the reach required for a load pick-up is 145 feet from the mast, and you have a counterweight at 25 feet from the mast, what must the counterweight have to be to pick a load weighing 350,000 lbs?

$$\frac{1}{7} (350,000 \text{ lbs}) = 50,000 \text{ lbs}$$

$$F_1 D_1 = F_2 D_2$$

$$F_1 (25 \text{ ft}) = (50,000 \text{ lbs})(145')$$

$$F_1 = \underline{\underline{290,000 \text{ lbs}}}$$

Group Exercises



4. Suppose a mobile crane wanted to lift a 234,500 lbs container. The mobile crane uses an 5-part cable that is 2.0 inches in diameter and a pulley that has a frictional coefficient of 4.4%. However, the cable is new so no safety factor is applied. Can the crane pick up this load safely?

$$L_L = \frac{\text{Load}}{n} (1 + f_f)^s$$
$$L_L = \frac{234,500 \text{ lbs}}{5} (1 + .044)^s$$
$$= 58,167 \text{ lbs}$$
$$\text{SAFE WORKING LOAD} = D^2 \times 8$$
$$= (2 \text{ in})^2 \times 8$$
$$= 32 \text{ tons}$$
$$32 \text{ tons} \times \frac{2000 \text{ lbs}}{1 \text{ ton}} = 64,000 \text{ lbs}$$
$$L_L < \text{SWL}$$

YES, THIS CRANE CAN PICK-UP
LOAD SAFELY

Group Exercises

1. During a sound survey, you notice that a safe zone at 6 feet was established around a generator. At that safe zone, you measure 88 dB. What is the estimated noise level at 1 foot from the generator?

$$dB_1 = dB_0 + 20 \log \frac{1}{6}$$

$$88dB = dB_0 + 20 \log \frac{1}{6}$$

$$88dB = dB_0 + (-15.6)$$

$$\underline{103.6dB = dB_0}$$

2. If a worker was exposed to 55 ppm of Toluene for 2 hours, 60 ppm for 2 hours, and 6 hours at 0 ppm, where he worked in the office, was the worker exposed to over the TLV of 50 ppm?

$$\frac{(55 \times 2\text{hrs}) + (60 \times 2\text{hrs}) + (0 \times 6\text{hrs})}{8} = 28.8 \text{ ppm} < 50 \text{ ppm TLV}$$

NOT exposed

Group Exercises

4. If a worker is exposed to over 500 ppm of benzene, and you want the exposure decreased to $\frac{1}{2}$ of the PEL of 1 ppm, what is the minimum respirator type to recommend.

$$PF = \frac{\text{Conc}_{\text{out}}}{\text{Conc}_{\text{in}}} = \frac{500 \text{ ppm}}{0.05 \text{ ppm}} = \frac{10,000}{\text{Pressure Demand SCBA}}$$

5. If a chemical has a TLV of 2 ppm but is generating vapors at 1.2 pints per 1 hour, what is the minimum ventilation flowrate needed to keep the vapors below the TLV? Specific Gravity is 2.3, Molecular Weight is 104.5, and use a safety factor of 2.

$$Q = \frac{403 \times 10^6 \times ER \times SF \times SG}{MW \times C} = \frac{403 \times 10^6 \times 2.3 \times 0.02 \times 2}{104.5 \times 2 \text{ ppm}} = \frac{111,400}{0.4 \text{ min}} = 278,500 \text{ cfm}$$
$$ER = \frac{1.2 \text{ pts}}{\text{hr}} \times \frac{\text{hr}}{60 \text{ min}} = 0.02 \text{ pts/min}$$

Group Exercise

1. As the Safety Manager, you have 7 generator stations, all of which are identical in terms of their power output and manufacture make/model. Your IH staff measure the following noise levels: 95 dB, 100 dB, 97 dB, 102 dB, 99 dB, 110 dB, 105 dB. What is the standard deviation of the noise generated?

$$m_{\text{mean}} = \bar{x} = \frac{95 + 100 + 97 + 102 + 99 + 110 + 105}{7} = 101.14 \text{ dB}$$

$$SD = \sqrt{\frac{\sum (x_i - \bar{x})^2}{n-1}} = \sqrt{\frac{(95-101.14)^2 + (100-101.14)^2 + (97-101.14)^2 + (102-101.14)^2 + (99-101.14)^2 + (110-101.14)^2 + (105-101.14)^2}{7-1}}$$

$$= 5.1$$

2. Your response staff has two Photoionization Detectors for detecting leaks in and around your storage tank farm. PID A measures 15 different locations in the tank farm and gets a mean of 5.6 ppm with standard deviation of 3.2. PID B measures the same 15 locations as PID A, but gets a mean of 4.6 ppm with standard deviation of 4.2. Which PID has better precision? $CV = 100 \left(\frac{SD}{\bar{x}} \right)$

$$CV_A = 100 \left(\frac{3.2}{5.6} \right) = 57.1$$

$$CV_B = 100 \left(\frac{4.2}{4.6} \right) = 91.3$$

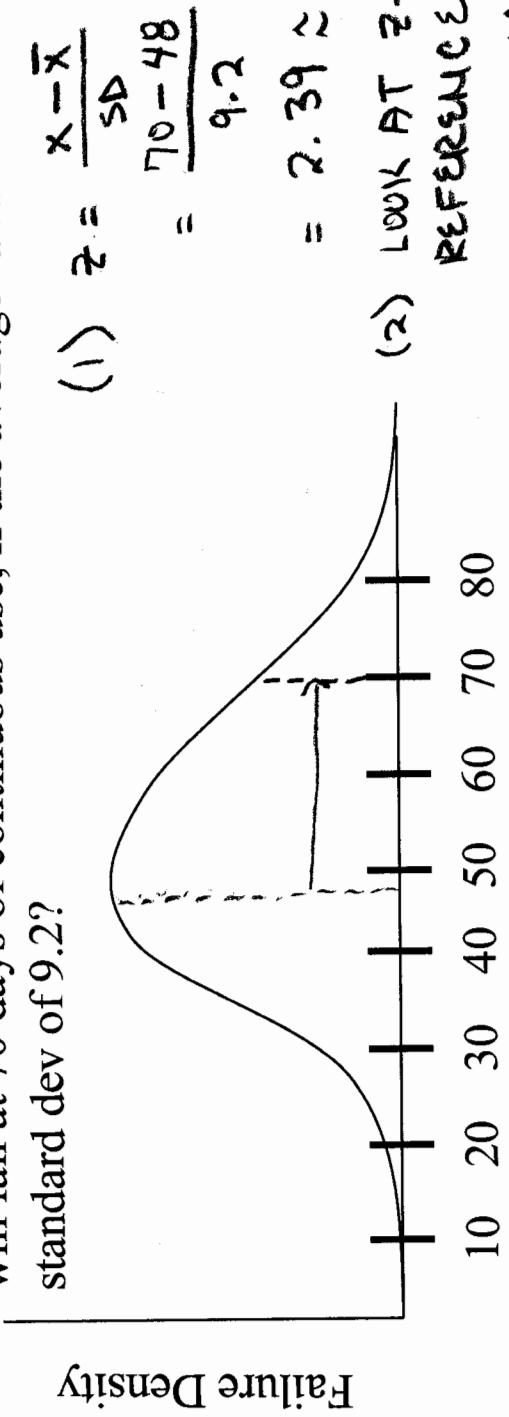
$\Rightarrow \text{PID A}$

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Group Exercise

- You noticed that hydraulic system of your 1K forklifts have failed after constant use.
3. You tracked the failure rates below. What is the probability that your 1K forklift will fail at 70 days of continuous use, if the average failure rate is 48 days, with standard dev of 9.2?



(2) LOOK AT Z-TABLE IN
REFERENCE GUIDE
 $2.4 = 0.4918 = \text{Area Under}$
curve AS SHOWN

99.2% PROBABILITY
THAT 1K FORKLIFT
WILL FAIL AT 70 DAYS
CONTINUOUS USE

END

Group Exercise

4. Centers for Disease Control and Prevention reports a incident rate of 3.5 per 100,000 of food poisoning in the US last month due to food eaten/purchased at a food service establishment. In your base, where you have over 20 snack bars/concessionaries leader's clubs serving food, what is the probability that your base of 50,000 will get more than 2 cases of food poisoning this month?

$$P = \frac{\lambda^x e^{-\lambda}}{x!}$$

$$50,000 \times \frac{3.5}{100,000} = \lambda = 1.75$$

$$P_2 = \frac{(1.75)^2 e^{-1.75}}{2!} = 0.266$$

$$P_1 = \frac{(1.75)^1 e^{-1.75}}{1!} = 0.304$$

$$P_0 = \frac{(1.75)^0 e^{-1.75}}{0!} = 0.174$$

$\frac{0.174}{0.744} \Rightarrow 74.4\% \text{ probability of more than 2 foodborne cases on BASE}$

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